National Park Service
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Natural Resource Program Center

Bat Inventory and Monitoring Program Development for Mount Rainier National Park, Washington
2000 Final Report

Natural Resource Technical Report NPS/NCCN/NRTR—2009/170

ON THE COVER
Jim Petterson mist netting at Mount Rainier National Park
Photograph by: Elaine Acker, Bat Conservation International

Bat Inventory and Monitoring Program Development for Mount Rainier National Park, Washington

2000 Final Report

Natural Resource Technical Report NPS/NCCN/NRTR—2009/170

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Problem Setting

Many of the bats in the Pacific Northwest have a strong association with lower-elevation, old-growth forests that is believed to be the result of bats selecting roosts located in the cracks, peeling bark, and cavities of snags and damaged trees predominantly found in these older forests (Thomas and West 1991). However, in most areas in this region, such old-growth stands have been harvested, being replaced with young, structurally simplified Douglas-fir (*Pseudotsuga menziesii*) stands. Mount Rainier National Park represents the largest area of late-successional forest in the Cascade Range of southern Washington (see map), and likely serves as an important refugium for many of these bat species. However, very little work has been done historically to examine bat abundance and distribution within the park. Various collecting expeditions targeting birds and mammals were conducted in 1906, 1921, and 1935, and resulted in a few bat voucher specimens (Taylor and Shaw 1927), but a systematic inventory for bats has never been undertaken. As an illustration of the relative lack of information relating to bat distribution in the park, the long-eared *Myotis* (*Myotis evotis*) was just added to the park mammal species list in 1999 when a small maternity colony was discovered in a warehouse building just 100 feet from the Resource Management Office.

The 1994 Northwest Forest Plan identified 11 species of bats that are associated with late-successional stage forests (USDA and USDI 1994, Table 1). These include eight species of *Myotis* (*M. californicus, M. evotis, M. keenii, M. lucifugus, M. thysanodes, M. volans* and *M. yumanensis*), big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), hoary bats (*Lasiurus cinereus*), and western big-eared *(Corynorhinus townsendii*). At present, all of the *Myotis* species and the big brown bat are on the Washington State Priority-Habitats and Species List and two species *(Corynorhinus townsendii*) and *Myotis yumanensis*) are listed as Federal Species of Concern. Nine of the 11 species listed above were either known or suspected to occur within park boundaries prior to 2000: Yuma *Myotis*, long-legged *Myotis*, California *Myotis*, little brown *Myotis*, long-eared *Myotis*, big brown, western big-eared, silver-haired, and hoary bat. However, a thorough inventory was needed to verify how many of these species still reside in the park.

Table 1. Common and scientific names of bats found in the Pacific Northwest.

Common Name	Scientific Name
Pallid bat	*Antrozous pallidus**
Big brown bat	*Eptesicus fuscus*
Spotted bat	*Euderma maculatum**
Silver-haired bat	*Lasionycteris noctivagans*
Hoary bat	*Lasiurus cinereus*
California myotis	*Myotis californicus*
Western small-footed bat	*Myotis ciliolabrum**
Long-eared myotis	*Myotis evotis*
Keen’s myotis	*Myotis keenii*
Little brown myotis	*Myotis lucifugus*

Table 1. Common and scientific names of bats found in the Pacific Northwest (continued).

Common Name	Scientific Name
Fringed myotis	*Myotis thysanodes*
Long-legged myotis	*Myotis volans*
Yuma myotis	*Myotis yumanensis*
Western pipistrelle	*Pipistrellus pipistrellus**
Western big-eared bat	*Corynorhinus townsendii*
Brazilian free-tailed bat	*Tadarida brasiliensis**

* Not likely to be in the study area.

The National Park Service announced the Natural Resource Challenge in August 1999 as a means of incorporating better science into park management decisions. One of the goals of this program is to better document the presence and relative abundance of vertebrate animals within parks, as a means to better understand which species need more protection and to prioritize efforts at doing so. All three of the large national parks in Washington, (Olympic, North Cascades, and Mt. Rainier), have identified bats as one of the groups of vertebrates for which basic presence and distribution information is sorely lacking. Consequently, all three parks have embarked upon efforts to conduct field work to fill in the data gaps that exist for bats.

This report summarizes the results of efforts undertaken during one field season at Mt. Rainier N.P. The information gained from the study is being used to develop an effective bat monitoring plan and facilitate development of an effective and humane plan to exclude bats from buildings in which their occupancy poses risks to public health. Educational and interpretive materials and informational talks are being developed for incorporation into visitor talks to increase their understanding and appreciation of the important role that bats play in the ecosystem.

Objectives

1. Survey the bat community of Mount Rainier N.P., and collect baseline ecological data, including:

   - species composition and seasonal occurrence through spring, summer, and fall;
   - relative abundance and/or activity levels of different species;
   - general information on distribution and habitat occurrence of different species;

2. Examine buildings and abandoned mines for presence of bats and indications of past use.

3. Collaborate with other Washington national parks in performing bat field work.

4. Provide interpretation division with park-specific bat baseline information for use in visitor programs.

Methods

During 2000, baseline data were gathered on bat species presence, distribution, habitat use and relative abundance/activity within Mount Rainier National Park. Potential study sites were identified across the broad range of elevation and habitat types throughout the park and a subset of samples were selected randomly on which to focus study efforts. Foraging areas and travel corridors within sites were sampled, using both conventional netting techniques and ultrasonic echolocation detection technology simultaneously. In addition to focusing on "natural" bat habitats, buildings and abandoned mines were also examined for presence of bats and indications of past use.

Field Work

Study Area

Mount Rainier National Park is a 240,000 acre preserve located in west-central Washington on the western slope of the Cascade mountains (Figure 1). Elevations range from 553 m in the northwest corner to 4,433 m at the summit. This large elevation gradient results in a wide variety of ecosystems, from the old-growth rainforests and mixed conifer forests at lower elevations, to subalpine parklands in mid-elevations, to huge glacial deposits, rock and ice outcrops that exist between 2,500 m and the summit. Fall through spring tends to be wet and overcast, with November to April being the months with most precipitation. The summers are typified by dry, warm conditions between July and September, however, heavy snowfalls, exceeding 1000 inches in some years, results in ice persisting on many sub-alpine lakes until well into August. The bat inventory covered in this report focused on forested, wetland, and pond/lake habitats below 2,000 m.

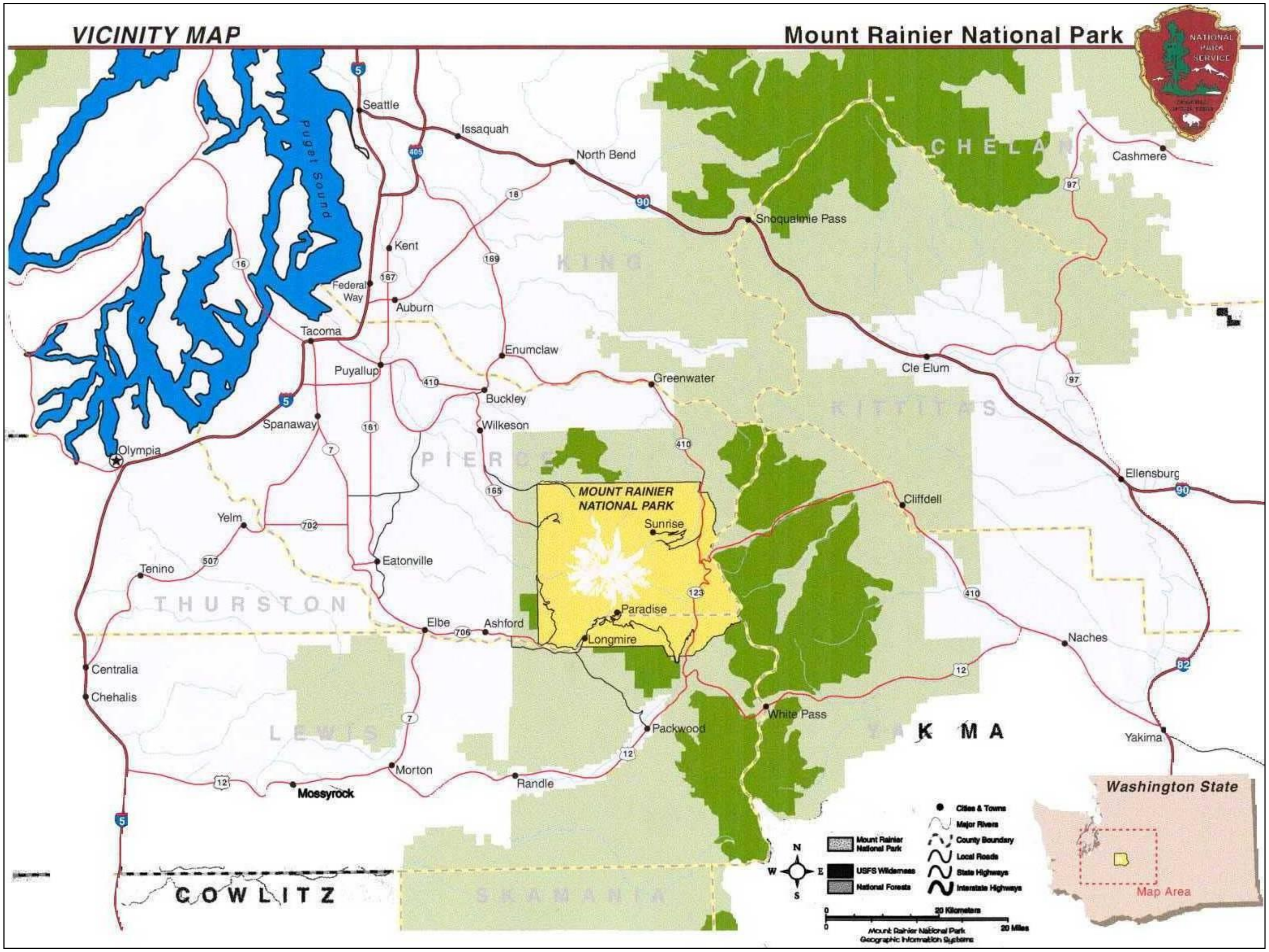

Figure 1. Mt. Rainier N.P. and vicinity.

Three broad habitat strata were defined across the broad range of elevation and habitat types throughout the park to assist in sample design: braided riparian backwaters, low elevation forest, and subalpine forest. Since one of the main purposes of the study was to document as many bat species as possible, potential study sites were chosen both selectively and randomly to maximize the likelihood of encountering bats. Each of the 3 strata had 15 sites allocated, with 5 of these being randomly placed by the computer, and 10 sites being determined selectively by the primary investigator (Figure 2). For random sites, the field crews located the computer-generated random point using GPS and topographic maps and then went to the closest suitable netting site. Selectively chosen sites were evaluated by considering the feasibility of netting based on the pond or stream characteristics, proximity to snags suitable for roosting, and logistics factors.

The braided riparian backwater stratum was located in lower elevation regions below 900 m where low-gradient, larger order rivers formed numerous meandering, braided sections where slow moving pools and rivulets abounded. These microhabitats offered bats suitable foraging and drinking opportunities and were places where researchers could effectively string nets. Vegetation consisted of red alder (*Alnus rubra*), cottonwood (*Populus trichocarpa*), western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*) overstories, and an understory dominated by vine maple (*Acer circinatum*), skunk cabbage (*Lysichitum americanum*), salal (*Gaultheria shallon*), and sword ferns (*Polystichum munitum*).

The low elevation forested stratum lay below 1,350 m and was dominated by western hemlock, Douglas fir, and Pacific silver fir (*Abies amabilis*) overstories. Study sites within the stratum were located at ponds and higher-gradient, smaller order streams. The distinction between the braided riparian backwater and low elevation forested strata was that the former had a much wider riparian influenced vegetation community, was typically lower in elevation, and the lower gradient rivers formed many more pools and slow moving sections.

The subalpine stratum varied between 1,350 and 2,000 m and consisted of a mosaic of forested islands and open meadows that harbored ponds, lakes, and ephemeral wetlands. Dominant tree species included mountain hemlock (*Tsuga mertensiana*), subalpine fir (*Abies lasiocarpa*), and Pacific silver fir.

Foraging areas and travel corridors within study sites were sampled between June 12 and October 5, 2000 using both conventional netting techniques and ultrasonic echolocation detection technology simultaneously (Appendix 1 and 2). At night, two to four mist nets were deployed at each study site, depending on the number of personnel available to work the nets, the physical layout of the site, and the amount of bat activity. Nets were opened just before dusk, and were kept open until for at least 4 hours. Captured bats were identified, aged, sexed, checked for reproductive condition, and basic morphological measurements were recorded (e.g. weight, forearm, foot, tail, and ear length. Wing punch biopsies were collected and stored in DMSO solution for subsequent DNA analyses. We did not collect specimens except for incidental net mortalities or bats found dead at roosts. All mist net site locations were noted on 1: 24,000 USGS maps after obtaining GPS locations and entered in an ACCESS database for linking with the Mt. Rainier’s National Park's GIS. Summary data for each net site included

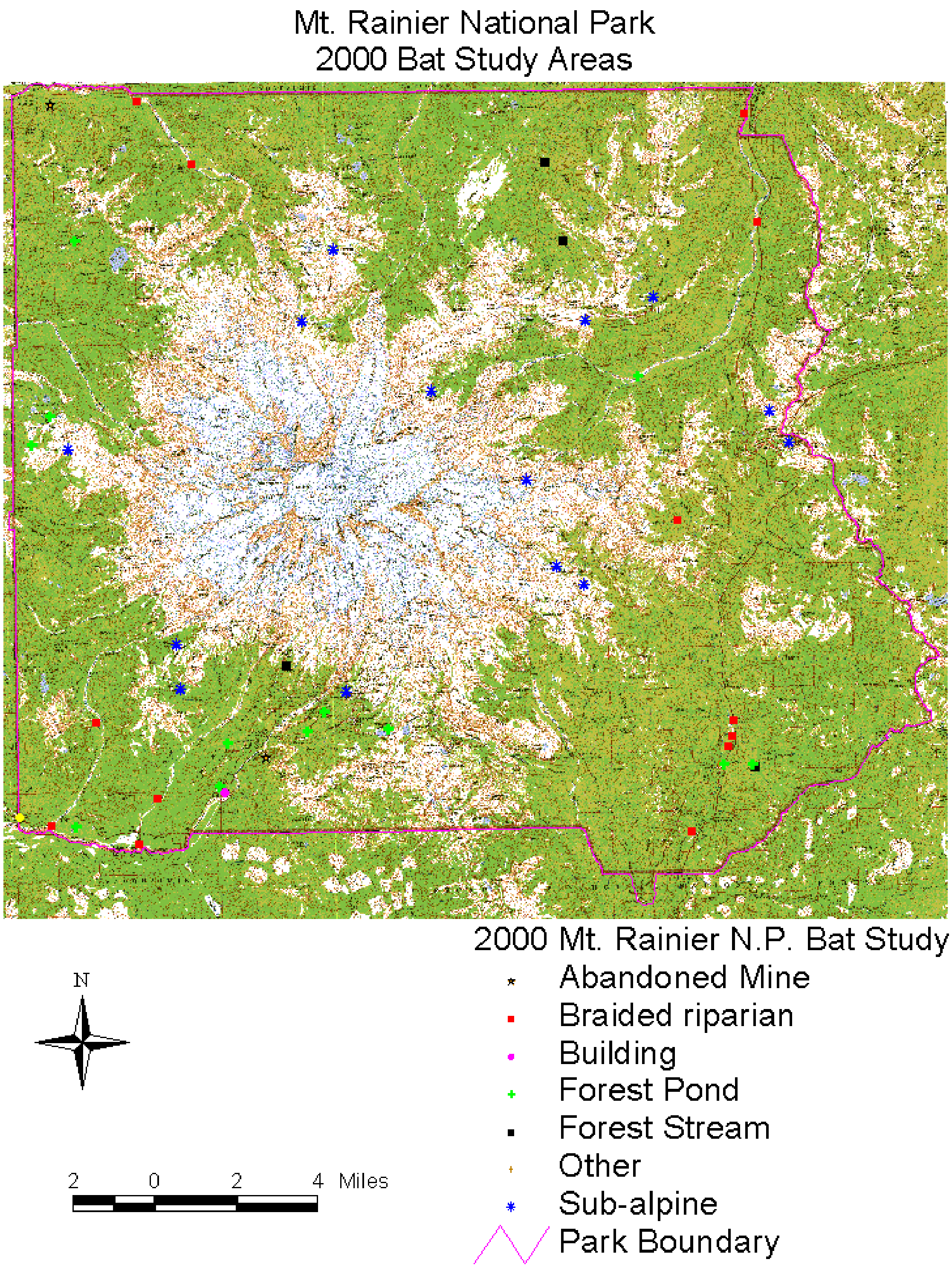

Figure 2. Study site locations for 2000 Mt. Rainier N.P. bat study.

general habitat features of the site (topographic position, vegetation type, presence and character of any water in the vicinity), weather conditions, in addition to the capture data.

Captured individuals were then released in open clearings and followed with a spotlight and Anabat ultrasonic recorder connected to a laptop computer to record verified vocalizations. At least one ultrasonic recorder was used at each study site, in addition to mist nets. Usually one Anabat system was operated in "passive" mode where it automatically recorded calls of any passing bat on a computer, and another was operated by a human in "active" mode. The "active" mode operation allowed the user to more efficiently locate bats and aim the Anabat unit at the bat, along with the spotlight, thereby obtaining higher quality calls along with the associated visual cues gained from the spotlight observations. These visual cues include bat color, flight speed, wingbeat patterns, and relative size, which can provide important clues to make determinations between some groups of hard to identify species.

Ultrasonic surveys have some important advantages as compared to mist net surveys; many bat species are difficult to capture in nets, and ultrasonic recorders are not limited to use around water and other concentration areas for bats (Thomas and West 1989). Surveys using recorders for bat calls have been shown to be particularly useful for rare, widely ranging species (Fenton et al. 1987). The recorder used in this study was the Anabat II bat detector, a countdown type recorder designed specifically for identifying microchiropteran bats by the pulse rate and time pattern of the dominant frequency of their calls (Hayes and Hounihan 1993, Hayes and Hounihan 1994, Fenton 1988). The entire echolocation sequences (approach phase, increase repetition phase, and feeding buzz) were recorded in the field, stored onto laptop computers, and later analyzed in the office. Numbers of passes were tallied into 15 minute blocks for each species or group of species at each site to obtain activity indices. Recordings made in the field were compared with known reference recordings for positive species identification. Anabat recordings were saved as computer files, providing a permanent record of what was recorded at each site.

It is acknowledged that not every recorded call of every bat can be positively identified to species with Anabat ultrasonic recorders. However, our Anabat expert, Chris Corben, felt that he could separate calls into conservative groupings depending on how well he saw the bat and the relative quality of the recorded call (Table 2). For fair quality calls, we used a *Myotis*/non-*Myotis* grouping. With increasing quality of calls and visual cues, more definitive distinctions could be made between groupings of *Myotis* and the non-*Myotis* group, based on the characteristic frequency of the *Myotis* calls and observation of behavior, relative size, color, wingbeats, etc. For example, if a non-*Myotis* bat with a 25 Khz characteristic frequency was recorded and simultaneously observed sufficiently well with a spotlight while it was flying/circling in the vicinity, distinctions could be made between *Lasionycteris noctivagens* and *Eptesicus fuscus*. This was done by noting the light colored, V-shaped pattern discernable on the ventral surface of the *L. noctivagens* that is not seen on the *E. fuscus*. For *Myotis* individuals that had been captured and skull morphology and fur coloration examined, along with obtaining a high quality echolocation recording upon release, distinctions could be made between *M. lucifugus* and *M. yumanensis* based on the different characteristic frequencies (calls between 35 and 43 Khz. vs. calls > 45 Khz).

Table 2. Summary of identification groupings of sorted Anabat recordings.

Quality of Calls/Visual Cues/Capture Exam	Groupings	Comments
Fair/Poor/No capture exam	*Myotis*/Non-*Myotis*	Coarsest resolution, but most conservative.
Fair/Fair/No capture exam	*Myotis*/Q25 Khz/*Lasiurus*	**Q25 Khz**= *Eptesicus fuscus* or *Lasionycteris noctivagens*
Good/Fair/No capture exam	30Khz *Myotis*, 40K *Myotis*, 50K *Myotis*/ Q25 Khz/*Lasiurus*	**30Khz *Myotis***= *M. evotis* or *M. keenii* with calls < 32 Khz. **40K *Myotis*** = *M. volans* or *M. lucifugus* with calls between 35 and 43 Khz. **50K *Myotis***= *M. californicus* or *M. yumanensis* with calls > 45 Khz..
Good/Good/No capture exam	30Khz *Myotis*, 40K *Myotis*, 50K *Myotis/Eptesicus/Lasionycteris/Lasiurus*	Visual cues used to distinguish between *Eptesicus fuscus* and *Lasionycteris noctivagens*.
Good/Good/Capture exam	*Myotis* spp./*Eptesicus*/*Lasionycteris*/ *Lasiurus*	Known release call characteristic frequencies used to distinguish between *M. yumanensis* and *M. lucifugus*

Potential day and night bat roosts were also examined during the course of the study by checking building attics, under bridges, and in abandoned mines. Two building attics, seven bridges, and three mines were visited at various times throughout the summer and fall. Exit counts were also done at 2 buildings.

Survey personnel included the principle investigator for this proposal, qualified field biologists hired on a temporary basis, and trained interns. In addition, Chris Corben, an Anabat echolocation expert contracted out his expertise towards this project.

Analysis

Reference Anabat recordings of known bats (mist net captures) were analyzed using Anabat analysis software (ANALOOK) to record frequency, duration, and pattern of frequency change for all calls recorded. In conjunction with published references on call characteristics of different bat species (e.g. Fenton and Bell 1981) and libraries of known-species calls from other researchers, we used these reference recordings to identify all other unknown calls recorded during the course of the survey at each site.

Combined data from mist net captures and Anabat recordings were used to evaluate bat species composition at each site, distribution, relationship to habitat parameters (elevation, topographic position, proximity to water, vegetation type), and seasonal occurrence patterns. Relative abundance/activity measures were calculated separately using the mist net capture data and the Anabat recordings. Data summarizing numbers of bats captured vs. numbers of active passes recorded (Appendix 2) were compared using linear regression.

Location of all sites included in the survey, including buildings, mines and other roosts, and mist net and Anabat sites, were recorded using GPS units and transferred to park GIS coverages. All site data has been entered into the Mount Rainier National Park GIS to link the information to elevation, topography, and other GIS base themes, for use in analyzing the distribution of bats sampled. Site information and bat species data will be maintained as part of the park GIS for research and management purposes at Mount Rainier National Park and other interested agencies.

Project Timeline

November 1999 to March 2000: Gathered field notes and pertinent museum records for any bat observations or collections within Mt. Rainier N.P.

February 15 – May 31, 2000: Select field study sites, provide contractor specifications, hire personnel.

June 1 – October 1, 2000: Conduct field work

October 1 – November 1, 2000: Complete data entry.

November 1, 2000 – July 31, 2001: Compile and analyze data; complete final report.

Project Cost Summary

Project Total $42,712

Funding Received from BCI:

One seasonal field biologist for 5 weeks	**$2,812**

Funding Contributed by Washington National Park FUND:

One seasonal field biologist for 6 weeks	$3,550
Ultrasonic bat recording specialist subcontractor	6,350
Washington National Park FUND Total	**$9,900**

Funding Contributed by NPS:

One seasonal field biologist for 14 weeks	$ 9,100
1 SCA Intern	2,100
Mt. Rainier Wildlife Ecologist to manage project	8,000
Three ultrasonic bat detectors/software	4,250
Mist nets and poles	1,400
Rabies Shots and medical screening for biologists	1,150
GPS/other supplies	1,750
One vehicle for 4 months @ $500 per month	2,000
Report Preparation and Interpretive Materials	250
NPS Total	**$30,000**

Partners

In addition to the $30,000 committed to the project by the National Park Service and the Washington National Park FUND, Bat Conservation International awarded $2,812 to Mount Rainier NP to further efforts. Two other National Parks in Washington, Olympic and North Cascades, were also conducting bat inventories and developing monitoring programs during 2000. Personnel from the Mt. Rainier project assisted biologists from these other two parks during field work in June. All parties felt that the exchange of information, working alongside each other and comparison of Anabat files from the three parks contributed towards all parks doing work in a standardized fashion.

Wing biopsy samples from bats captured in Mt. Rainier N.P. and tentatively identified as *M. evotis* were forwarded to that a University of Michigan graduate student that is investigating long-eared *Myotis* species throughout their ranges. Genetics work will be done to try to see whether *M. keenii* had, in fact, been captured during the summer. Results are pending from this work.

Results

Mist netting

Mist netting and Anabat acoustic monitoring techniques were used in tandem at a total of 43 sites between June 13 and September 28, 2000 (Appendix 1 and 2). Three of the 43 sites were visited on at least 2 occasions to examine seasonal differences in bat species composition. A total of 72 bats were captured with 550 total net-hours of effort during 46 nights of sampling (range = 0 to 12 captures/site, avg. = 1.55 captures/site). Sex ratios of captures were 30% female/70 % male, while only 5 of 72 bats caught were juveniles. Seven species were positively identified from captures including: *Myotis yumanensis*, *Myotis volans*, *Myotis californicus*, *Myotis lucifugus, Myotis evotis*, *Eptesicus fuscus*, and *Lasionycteris noctivagens*. One additional species, *Lasiurus cinereus*, was documented using Anabat acoustic sampling and spotlights. The ninth bat species confirmed as occurring in the park, *(Corynorhinus townsendii*), was documented at an abandoned mine site in a hibernaculum on November 2 and 6, 2000 when 23 individuals were observed in a dormant condition.

Differences existed in numbers of captures in the 3 habitat strata and between taxa (Table 3) with subalpine habitats accounting for 52% of the total captures; roughly twice as many as the other strata. *Myotis lucifugus* was the most frequently captured bat, being caught 51% of the time. This figure was undoubtedly even higher, since 13 animals could not be distinguished between *Myotis lucifugus* and *M. yumanensis* due to the fact that animals were not sacrificed in this study to make definitive identifications. Also, in these instances, insufficient quality echolocation recordings upon release prevented making distinctions between these hard to separate species.

Table 3. Mist net captures of bats in 3 habitat strata in Mt. Rainier National Park during 2000.

Species	Braided Riparian Backwater	Low Elevation Forest	Subalpine	Totals
Eptesicus fuscus	0	0	1	1
Lasionycteris noctivagens	1	3	3	7
Myotis californicus	2	3	0	5
Myotis evotis	0	1	2	3
Myotis lucifugus	6	9	21	36
Myotis volans	1	0	2	3
Myotis yumanensis	3	0	0	3
Myotis lucifugus or M. yumanensis	2	3	8	13
Totals	15	19	37	71

At the 3 sites that were netted twice during the summer, 2 of these yielded more captures during June/July than August/September (5 vs. 1 captures). The other site failed to produce any bats during either visit.

Anabat Acoustic Monitoring

Both "active" and "passive" Anabat acoustic monitoring were used during the study as described earlier. At the 43 survey sites where active Anabat monitoring occurred in conjunction with netting, a total of 4,708 bat activity passes (range 0 to 487 passes/site, avg. = 92 passes/site) were recorded and have been identified with sufficient detail to make groupings to at least the levels mentioned in Table 2. The passive Anabat monitoring techniques were used when personnel and equipment logistics permitted, but on a more limited basis than active monitoring. Consequently, only 18 of the 43 sites had netting and both active and passive acoustic monitoring. There were a total of 742 activity passes recorded with the passive monitoring efforts (range 0 to 165 passes/site, avg.= 26 passes/site).

At those sites where Chris Corbin (the Anabat expert) was performing active acoustic monitoring, the numbers of species documented varied from 1 to 6 spp/site. If only the more conservative groupings were used at these sites, they varied from 1 to 5 groupings/site.

Table 4. Numbers and percentages of active Anabat calls separated into 2 conservative taxa groupings for each of 3 habitat types.

Habitat Type	Myotis	Non-*Myotis*	Total Calls
Braided Riparian Backwater	302 (57.6%)	222 (42.4%)	524
Low Elevation Forest	1562 (60.9%)	1003 (39.1%)	2565
Subalpine	1004 (82.3%)	216 (17.7%)	1220
Totals	2868 (66.6%)	1441 (33.4%)	4309

Table 5. Numbers and percentages of active Anabat calls separated into more detailed taxa groupings for each of 3 habitat types.

Habitat Type	unknown *Myotis*	MY50Khz	MY40Khz	MY30Khz	Q25Khz	*Lasiurus cinereus*	Totals
Braided Riparian Backwater	93 (17.8%)	67 (12.8%)	130 (24.8%)	12 (2.3%)	220 (42%)	2 (0.4%)	524
Low Elevation Forest	99 (3.9%)	214 (8.3%)	1207 (47.1%)	41 (1.6%)	978 (38.1%)	25 (1%)	2565
Subalpine	159 (13%)	4 (0.3%)	819 (67%)	22 (1.8%)	184 (15.1%)	32 (2.6%)	1220
Totals	351 (8.2%)	285 (6.6%)	2156 (50.1%)	75 (1.7%)	1382 (32.1%)	59 (1.4%)	4309

Table 6. Numbers and percentage of sites within habitat types where taxa groupings were recorded as being present.

Habitat Type	unknown *Myotis*	MY50Khz	MY40Khz	MY30Khz	Q25Khz	*Lasiurus cinereus*	Total Number of Sites
Braided Riparian Backwater	4 (36.4%)	9 (81.8%)	11 (100%)	4 (36.4%)	9 (81.8%)	2 (18.2%)	11
Low Elevation Forest	8 (42.1%)	12 (63.2%)	14 (73.7%)	8 (42.1%)	13 (68.4%)	4 (21.1%)	19
Subalpine	10 (66.7%)	4 (26.7%)	14 (93.3%)	7 (46.7%)	13 (86.7%)	6 (40%)	15
Totals	22 (48.9%)	25 (55.6%)	39 (86.7%)	19 (42.2%)	35 (77.8%)	12 (26.7%)	45

There seemed to be no significant relationship between the numbers of bats captured and the numbers of active passes recorded at those sites where bats were both captured and recorded acoustically ($R^2 = 0.001$).

Bridge Searches

Bridges were checked for day and night roost activity, but very little evidence existed that bats used bridges for either of these activities. A total of 5 bridges were checked, 2 of which were visited twice.

Date	Bridge Name	Results
June 12, 2000	Tahoma Creek	No bats
September 26, 2000	Tahoma Creek	No bats
June 19, 2000	Kautz Creek	No bats
July 19, 2000	Kautz Creek	No bats
June 22, 2000	Shaw Creek	No bats
August 15, 2000	Paradise River	No bats
August 15, 2000	Glacier Bridge	One bat (unknown species)

Building Exit Counts

A couple of buildings were examined for presence of bats by performing exit counts and looking in the attic or upper floors. Two maternity colonies were discovered in the process.

Date	Building	# bats	Species
June 18, 2000	Nisqually House	86	Mostly *Myotis lucifugus*
August 13, 2000	Nisqually House	81	Mostly *Myotis lucifugus*, two *E. fuscus*
August 8, 2000	Longmire Warehouse	3	*Myotis evotis*

Mine Searches

The Eagle Peak mine was searched on November 2 and 6, 2000 to look for roosting bats (Figure 3). Upon visiting on November 2, we saw 23 Western big-eared bats (*Corynorhinus townsendii*) scattered throughout the vertical walls and low ceiling of the adit and also in various locations in the higher vaulted ceiling at the rear of the adit. No bats were observed closer to the entrance than 20 m. Most of the bats were roosting singly, although some groups of 3 were also seen. The bats seemed to be hibernating, as they were unresponsive to low noises and 17 of the bats held their ears folded over against their backs, with wings tucked over them. Six of the bats held their ears fully unfurled and open, however. The color of the fur was dark brown, with blackish-brown wing and tail membranes. The large ears, greater than 25 mm in length, combined with prominent lumps on either side of the nose, were definitive morphological characters that identified these bats as *Corynorhinus townsendii*. This was the first documented instance of this species being recorded in the park. Searches of 2 other abandoned mine workings failed to find any bats.

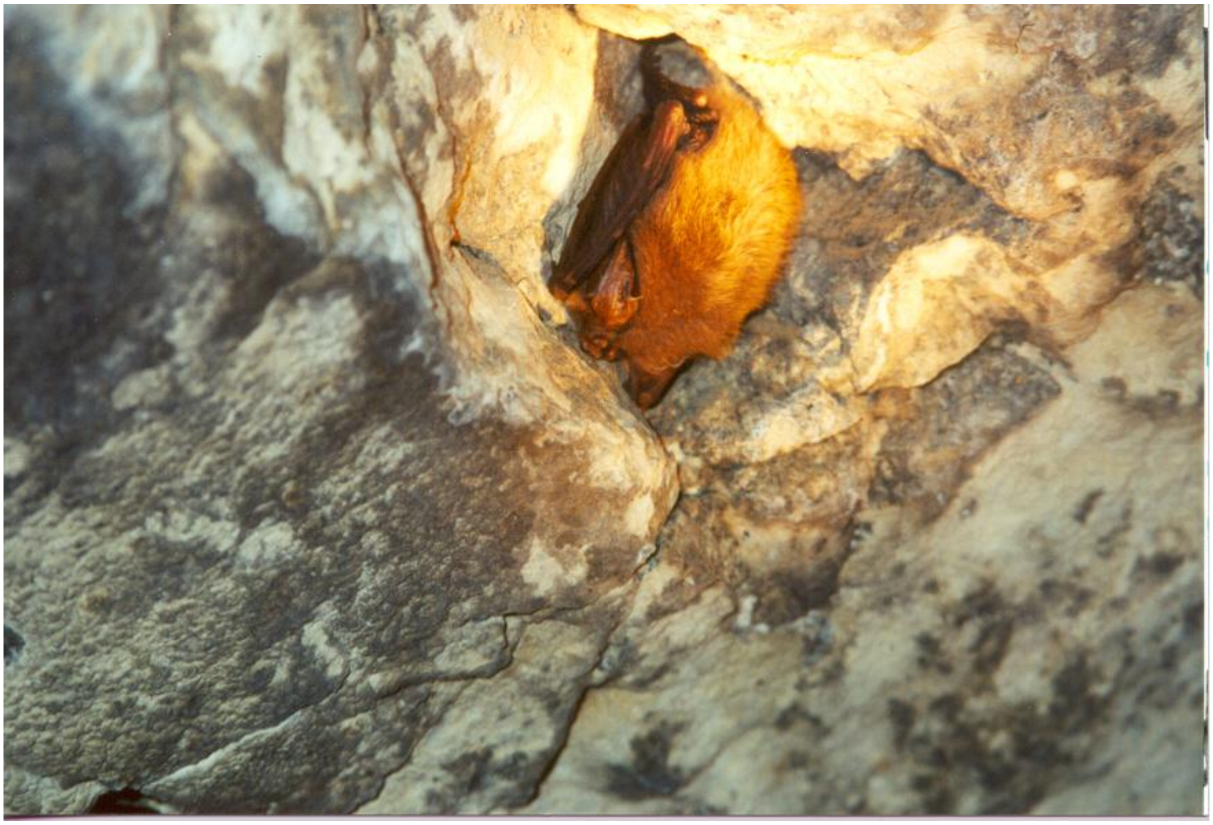

Figure 3. Hibernating Townsend's big-eared bat photographed Nov.6, 2000 in hibernaculum at Eagle Creek Mine, Mt. Rainier N.P. (Photo by Lucretia Fairchild).

Discussion

Based on capture and Anabat data, it appears that the most common bat to inhabit Mt. Rainier N.P. is *Myotis lucifugus.* With all habitats pooled, this species accounted for over half of all captures, and the 40 Khz *Myotis* group, which includes this species, represented slightly over half of the 4,309 total recorded "active" Anabat calls. The prevalence of *M. lucifugus* seemed to follow an elevational gradient, with a greater proportion of the total calls and the majority of captures occurring for this species at higher elevations. Finally, based on the acoustic data, they were documented as being present at 87% of all study sites. Since *M. lucifugus* and *M. yumanensis* are not reliably distinguished using Anabat alone, an unknown proportion of the 40 Khz *Myotis* group may have been *M. yumanensis*. However, since no *M. yumanensis* were captured until the very end of the season in September, and these were at lower elevations, I find it reasonable to believe that most of the calls put into the 40 Khz *Myotis* group were actually *M. lucifugus*. The remaining Myotis species seem to be relatively uncommon, with comparable abundances. The only discernable trend seemed to be that *M. californicus* was captured only in lower elevation habitats. The acoustic data supported this generalization also, since the 50 Khz *Myotis* group, which includes *M. californicus* was virtually absent at the higher elevation subalpine sites.

Referring to both the acoustic and capture data, *L. noctivagens* was the next most abundant and widely distributed bat. The Q25 grouping, which included both *E. fuscus* and *L. noctivagens* accounted for roughly a third of all recorded "active" calls. Also, when sufficiently good visuals were obtained to be able to separate the two species using a combination of calls and visual cues, the vast majority of the Q25 group were *L. noctivagens.*

Looking at the acoustic data in the most conservative manner, with the coarsest amount of resolution, roughly two-thirds of all "active" Anabat calls recorded over all habitats were attributed to the *Myotis* group and one-third to the non-*Myotis* group. The relative proportion of calls from the *Myotis* group was higher at higher elevations, with the non-*Myotis* group seemingly more active (or abundant) at lower elevations. As previously noted, the numbers of passes recorded with Anabat does not necessarily correspond with the numbers of actual bats, but is merely an indication of activity levels. While it seems reasonable to believe that activity levels are many times correlated with relative numbers, there is no certain way of distinguishing between successive passes recorded from the same individual and those made by a procession of different, unique bats. When grouped within habitat types, the capture data usually tracked what the acoustic data suggested in terms of relative abundances. Yet when examined at each capture site, there seemed to be no correlation between numbers of bats caught and numbers of calls recorded. Much of this is likely due to the great variability associated with how effectively different sites can be netted. Many sites that were characterized by high bat activity, as evidenced by acoustic monitoring, were also some of the most difficult to effectively net (due to large bodies of water, fast flowing rivers, and lack of features that funneled bats into nets). Conversely, some of the sites with less acoustic activity, had physical layouts which permitted more effective netting of the few bats that ventured into the area. Although acoustic monitoring has limitations and biases of its' own, when restricted to how well it characterizes bat activity within 40 m from ground level, my feeling is that it is more unbiased measure than numbers of bats captured. Despite more than 550 net-hrs of effort at 43 sites, only 72 bats were captured and these were limited to only 23 sites. The acoustic data provided a valuable complimentary index of activity, enabling comparisons between habitat types and coarse species groupings, which the capture data could not.

Human-built structures such as mines and buildings served as bat habitat in some cases, however, bridges appear to not be important for night roosting, based on the very few observations at bridges. A couple of maternity colonies were being supported by the presence of 2 structures. A house used for guest researchers had an exit count of over 80 *M. lucifugus* and a *M. evotis* maternity colony was documented as existing in the upper floor of the park warehouse.

An abandoned mine was found to support a hibernaculum of western big-eared bats, the first such recording of this species in the park. The park contains 8 known abandoned mines, of which 5 remain to be examined.

The information gathered from the inventory of 2000 is currently being used to develop a bat monitoring and impact mitigation program at the park.

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Appendix 1. 2000 Mt. Rainier N.P. Bat Survey Capture Results.

Date	Site Name	UTME	UTMN	Elev.(ft)	Habitat	Species Grouping	Total Captured	M/F	Repro Status	Adults	Juv.	Comments
06/13/00	Cedar Flats/Ohana River	610760	5180006	2210	Braided back water	MYLU/MYYU	2	0/2		2	0	
06/13/00	Cedar Flats/Ohana River	610760	5180006	2210	Braided back water	MYCA	1	0/1		1	0	
06/15/00	Longmire Meadows	590668	5178042	2700	Forest pond	MYCA	1	0/1		1	0	
06/16/00	Carbon River	589531	5202419	2550	Braided back water	MYCA	1	0/1		1	0	
06/19/00	Nisqually Random Point	584037	5176499	2080	Braided back water	LANO	1	1/0		1	0	
06/20/00	Rampart Ridge Pond	590988	5179732	3900	Forest pond	MYLU	3	3/0		3	0	
06/20/00	Rampart Ridge Pond	590988	5179732	3900	Forest pond	LANO	1	1/0		1	0	
06/23/00	Nisqually Bog	585035	5176458	2160	Forest pond	MYLU/MYYU	1	0/1	PREG	1	0	
06/23/00	Nisqually Bog	585035	5176458	2160	Forest pond	MYLU/MYYU	1	1/0		1	0	
06/23/00	Nisqually Bog	585035	5176458	2160	Forest pond	MYCA	1	UNK		1	0	ESCAPED
06/23/00	Nisqually Bog	585035	5176458	2160	Forest pond	MYLU	2	2/0		2	0	
07/11/00	Ohanapecosh/Grove Of Patriarchs	610630	5179609	2200	Braided back water	MYLU	1	0/1	PREG	1	0	
07/12/00	White River At BM 3047	611742	5200178	3000	Braided back water	MYVO	1	1/0		1	0	
07/17/00	Frog Heaven	594801	5180974	4400	Forest pond	MYEV	1	1/0		1	0	
07/17/00	Frog Heaven	594801	5180974	4400	Forest pond	MYLU	3	3/0		3	0	
07/17/00	Frog Heaven	594801	5180974	4400	Forest pond	MYLU/MYYU	1	1/0		1	0	
07/19/00	Kautz Creek Riverine Site	588228	5177554	2800	Braided back water	MYCA	1	0/1		1	0	
08/09/00	Sunrise Lake Area	607698	5197244	5650	Sub-alpine meadow	MYLU	1	1/0		1	0	
08/10/00	Stephens Canyon/Hwy 123 Jct	610457	5178874	2130	Forest pond	LANO	1	1/0		1	0	
08/10/00	Stephens Canyon/Hwy 123 Jct	610457	5178874	2130	Forest pond	MYLU	1	0/1		1	0	
08/14/00	Tipsoo Lake	613024	5191523	5230	Sub-alpine meadow	MYLU	1	0/1	LACT.	1	0	
08/14/00	Tipsoo Lake	613024	5191523	5230	Sub-alpine meadow	MYLU	1	0/1		1	0	
08/14/00	Tipsoo Lake	613024	5191523	5230	Sub-alpine meadow	LANO	1	1/0		1	0	
08/16/00	Ohanapecosh Campground	609166	5176301	1780	Braided back water	MYLU	1	0/1		0	1	
08/16/00	Ohanapecosh Campground	609166	5176301	1780	Braided back water	MYLU	2	0/2		2	0	
08/22/00	Frog Lake (Pond West Of Mystic Lake)	593932	5196279	6010	Sub-alpine meadow	MYLU/MYYU	3	3/0		3	0	
08/22/00	Frog Lake (Pond West Of Mystic Lake)	593932	5196279	6010	Sub-alpine meadow	MYLU	2	2/0		2	0	

Appendix 1. 2000 Mt. Rainier N.P. Bat Survey Capture Results (continued).

Date	Site Name	UTME	UTMN	Elev.(ft)	Habitat	Species Grouping	Total Captured	M/F	Repro Status	Adults	Juv.	Comments
08/22/00	Frog Lake (Pond West Of Mystic Lake)	593932	5196279	6010	Sub-alpine meadow	EPFU	1	1/0		1	0	
08/22/00	Frog Lake (Pond West Of Mystic Lake)	593932	5196279	6010	Sub-alpine meadow	LANO	1	1/0		1	0	
08/22/00	Frog Lake (Pond West Of Mystic Lake)	593932	5196279	6010	Sub-alpine meadow	LANO	1	0/1	PREG	1	0	
08/30/00	Glacier Basin Campground	599002	5193531	5870	Sub-alpine meadow	MYLU	4	4/0		4	0	
08/30/00	Glacier Basin Campground	599002	5193531	5870	Sub-alpine meadow	MYLU	1	0/1		1	0	
08/30/00	Glacier Basin Campground	599002	5193531	5870	Sub-alpine meadow	MYLU	1	0/1	PREG	1	0	
08/31/00	Ohana River, .6 Mi N. Of Steven's Canyon Rd	610823	5180656	2170	Braided back water	MYLU	2	0/2		2	0	
09/13/00	Pond SE Of Indian Bar	604979	5185958	5187	Sub-alpine meadow	MYLU	1	1/0		1	0	
09/14/00	Paradise Sewage Pond (Second Visit)	595648	5181767	4980	Sub-alpine meadow	MYLU	3	3/0	3-SCROTAL	3	0	
09/14/00	Paradise Sewage Pond (Second Visit)	595648	5181767	4980	Sub-alpine meadow	MYLU	6	6/0		5	1	
09/14/00	Paradise Sewage Pond (Second Visit)	595648	5181767	4980	Sub-alpine meadow	MYEV	1	1/0		1	0	
09/14/00	Paradise Sewage Pond (Second Visit)	595648	5181767	4980	Sub-alpine meadow	MYVO	1	1/0		0	1	
09/14/00	Paradise Sewage Pond (Second Visit)	595648	5181767	4980	Sub-alpine meadow	MYVO	1	1/0		1	0	
09/19/00	Mirror Lake	588996	5183556	5370	Sub-alpine meadow	MYLU	1	1/0		1	0	
09/19/00	Mirror Lake	588996	5183556	5370	Sub-alpine meadow	MYEV	1	1/0		1	0	
09/20/00	Squaw Lakes	589132	5181867	5000	Sub-alpine meadow	MYLU/MYYU	3	3/0		3	0	
09/20/00	Squaw Lakes	589132	5181867	5000	Sub-alpine meadow	MYLU/MYYU	1	1/0		0	1	
09/20/00	Squaw Lakes	589132	5181867	5000	Sub-alpine meadow	MYLU/MYYU	1	0/1		0	1	
09/25/00	Ranger Creek/Carbon River	587380	5204904	2110	Braided back water	MYYU	3	3/0		3	0	
09/26/00	Nisqually Bog (Second Visit)	585035	5176458	2160	Forest pond	LANO	1	0/1		1	0	
						TOTALS	**72**	**50/21**	**4 = P**	**68**	**5**	

Appendix 1. 2000 Mt. Rainier N.P. Bat Survey Capture Results (continued).

					Total Captured	M/F	1 = L	Adult	Juv.	
		Species Group Key					3 = S			
		Myotis lucifugus	**MYLU = 39**							
		M. yumanensis	**MYYU = 3**							
		M. lucifugus/M. yumanensis	**MYLU/MYYU =11**							
		M. evotis/M. keenii	**MYEV/MYKE = 3**							
		M. volans	**MYVO = 3**							
		M. californicus	**MYCA = 5**							
		Eptesicus fuscus	**EPFU = 1**							
		Lasionycteris noctivagens	**LANO = 7**							
			Total Captured 72							

Appendix 2. 2000 Mt. Rainier N.P. Bat Survey ANABAT Acoustic Monitoring Results

Date	Site Name	UTME	UTMN	Elev (ft)	Habitat	Spp. Groups Recorded	"Active" Calls Total	#/hr	Spp Captured	Total Bats Captured
06/12/00	Longmire Gas Station	590772	5177843	2760	Developed Area	MY50/MY30/Q25	15	6.1		0
06/13/00	Cedar Flats/Ohana River	610760	5180006	2210	Braided back water	MYCA/MY40/Q25	15	3.8	MYLU/MYYU, MYCA	3
06/14/00	Pond At Steven's Canyon Entrance	610249	5178992	2160	Forest pond	MY50/MY40/MY30/Q25	165	86.1		0
06/15/00	Longmire Meadows	590668	5178042	2700	Forest pond	MYCA/MY40/MY30/Q25	67	17.5	MYCA	0
06/16/00	Carbon River	589531	5202419	2550	Braided back water	MYCA/MY40	13	4.2	MYCA	1
06/19/00	Nisqually River	584037	5176499	2080	Braided back water	MY40/LANO	1	0.3	LANO	1
06/20/00	Rampart Ridge Pond	590988	5179732	3900	Forest pond	MY50/MYLU/MY30/LANO	252	70.3	MYLU, LANO	4
06/21/00	White River Near Silver Creek	611212	5204437	2800	Braided back water	MY50/MY40/Q25	206	61.8		0
06/22/00	White River Pond	607044	5194110	3560	Forest pond	MY50/MY40/MY30/Q25	290	96.7		0
06/23/00	Nisqually Bog	585035	5176458	2160	Forest pond	MYCA/MY40/Q25	487	139.1	MYLU/MYYU, MYCA	5
07/10/00	Overlook Loop Rd. Pond	594141	5180181	4280	Forest pond	MY40	23	23.0		0
07/11/00	Ohana River/Grove Of Patriarchs	610630	5179609	2200	Braided back water	MY50/MYLU/Q25	61	12.4	MYLU	1
07/12/00	White River At Bm 3047	611742	5200178	3050	Braided back water	MY50/MYVO/MY30/Q25	30	18.2	MYVO	0
07/17/00	Frog Heaven	594801	5180974	4400	Forest pond	MYLU/MYEV/Q25	9	4.6	MYLU, MYEV	5
07/18/00	Van Trump/Comet Falls	593260	5182739	4720	Forest stream	MY40	1	0.2		0
07/19/00	Kautz Creek Riverine Site	588228	5177554	2800	Forest stream	MYCA	1	0.7	MYCA	1
07/25/00	Huckleberry Creek	603396	5202455	3680	Forest stream	MY50/MY30	45	12.6		0
07/26/00	Prospector Creek	604108	5199403	5040	Forest stream	Q25	1	0.5		0
07/27/00	Sunrise Subalpine Meadow	605032	5196326	6240	Sub-alpine meadow	MY50/Q25	4	0.8		0
07/31/00	Golden Lakes Campground	584010	5192519	4920	Forest pond	MY50/MY40/MY30/Q25	79	55.1		0
08/01/00	Sunset Park Forest	583298	5191396	4960	Forest pond	MY40/MY30/LACI	8	5.6		0
08/02/00	Sunset Park Meadow	584745	5191234	5320	Sub-alpine meadow	MY50/MY40/MY30/Q25/LACI	38	12.5		0
08/07/00	Reflection Lake	597283	5180270	4940	Forest pond	MY50/MY40/Q25/LACI	56	34.6		0
08/08/00	Longmire Warehouse	590668	5178042	2760	Building	MY40/MY30/Q25	18	9.0		0
08/09/00	Sunrise Lake Area	607698	5197244	5650	Sub-alpine meadow	MY50/MYLU/MY30/Q25	69	20.4	MYLU	1
08/10/00	Stephens Canyon/Hwy 123 Jct	610457	5178874	2130	Forest pond	MY50/MYLU/MY30/LANO/LACI	432	113.7	MYLU, LANO	2
08/13/00	Nisqually House	582765	5176810	1880	Building	MY50/MY40/Q25/LACI	337	84.3		0
08/14/00	Tipsoo Lake	613024	5191523	5230	Sub-alpine meadow	MYLU/MY30/LANO/LACI	217	52.1	MYLU, LANO	3
08/15/00	Frog Heaven (2nd Visit)	594801	5180974	4440	Forest pond	MY40/Q25	9	4.6		0
08/15/00	Reflection Lake	597283	5180270	4940	Forest pond	MY40/Q25/LACI	128	41.5		0

Appendix 2. 2000 Mt. Rainier N.P. Bat Survey ANABAT Acoustic Monitoring Results (continued).

08/16/00	Ohanapecosh Campground	609166	5176301	1780	Braided back water	MY50/MYLU/Q25/LACI	102	27.8	MYLU	3
08/17/00	Mountain Meadows	585005	5199387	4040	Forest pond	MY40/MY30/Q25/LACI	480	140.5		0
08/22/00	Frog Lake (Pond West Of Mystic Lake)	593932	5196279	6010	Sub-alpine meadow	MY40/MY30/EPFU/LANO	61	17.6	MYLU/MYYU EPFU, LANO	8
08/24/00	Elysian Fields/Vernal Park	595151	5199097	6000	Sub-alpine meadow	MY40/Q25	5	2.0		0
08/28/00	Kautz Heliport	587475	5175777	2640	Braided back water	MY50/MY40/Q25/LACI	13	6.2		0
08/30/00	Glacier Basin Campground	599002	5193531	5870	Sub-alpine meadow	MY50/MYLU/MY30/Q25	48	15.6	MYLU	6
09/05/00	Tipsoo/Deadwood Pond	612274	5192744	5360	Sub-alpine meadow	MY40/Q25	5	2.2		0
09/06/00	Needle Creek	608587	5188458	4080	Braided back water	MY50/MY40/MY30/Q25	61	21.8		0
09/11/00	Summerland Pond	602700	5190030	6320	Alpine	MY40	37	11.1		0
09/12/00	Indian Bar	603858	5186667	5120	Sub-alpine meadow	MY40/Q25	11	3.6		0
09/13/00	Pond Se Of Indian Bar	604979	5185958	5187	Sub-alpine meadow	MYLU/MY30/Q25	369	110.7	MYLU	1
09/14/00	Paradise Sewage Pond (2nd Visit)	595648	5181767	4980	Sub-alpine meadow	MY50/MYLU/MY30/Q25/LACI	79	21.8	MYLU, MYVO	12
09/19/00	Mirror Lake	588996	5183556	5370	Sub-alpine meadow	MYLU/MYEV/Q25	150	43.7	MYLU, MYEV	2
09/21/00	Laughingwater Pond	611585	5178922	3040	Forest pond	MY50	3	1.0		0
09/25/00	Ranger Creek/Carbon River	587380	5204904	2110	Braided back water	MYYU/MY40/MY30/Q25	13	3.9	MYYU	3
09/26/00	NISQUALLY BOG (2nd VISIT)	585035	5176458	2160	Forest pond	MY50/MY40/LANO	148	45.5	LANO	1
09/27/00	Fish Creek	585824	5180528	2720	Braided back water	MY40/MY30/Q25	9	2.5		0
09/28/00	Paradise Sewage Pond (3rd Visit)	595648	5181767	5040	Sub-alpine meadow	NONE	0	0		0
						TOTAL	**4708**			
	Species Group Key									
	Q25 = *Eptesicus fuscus* or *Lasionycteris noctivagens*									
	MY30 = *Myotis evotis* or *M. keenii*									
	MY40 = *M. volans* or *M. lucifugus*									
	MY50 = *M. californicus* or *M. yumanensis*									
	MYLU = *Myotis lucifugus;* **MYYU** = *M. yumanensis*									
	MYEV = *M. evotis;* **MYVO** = *M. volans*									
	MYCA = *M. californicus*; **EPFU** = *Eptesicus fuscus*									
	LANO = *Lasionycteris noctivagens;* **LACI** = *Lasiurus cinereus*									

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